"NETWORK CENTRIC INFORMATION STRUCTURE - CRISIS INFORMATION MANAGEMENT"

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Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
JUN 2004		**00-00-2004 to 00-00-2004**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Network Centric Information Structure - Crisis Information Management	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Teleplan AS,Defence Division,PO Box 69,1324 Lysaker, Norway, ,**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**		**31**	

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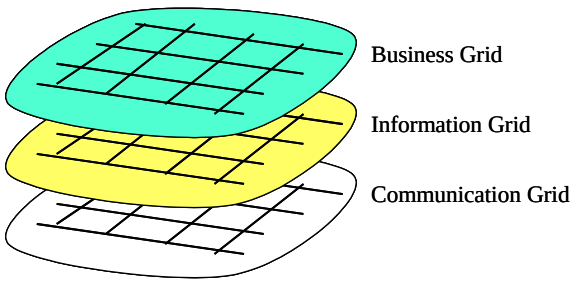
Abstract

This paper presents a generic Network Centric Information Structure (NCIS) that can be used by civilian, military and public sectors, and that supports information handling applied to crises management and emergency response. The top level requirements specification for such a network centric based system adapted to collect, handle and distribute important information is presented together with a suggested layout of a network centric demonstrator that supports the information management during emergency and crisis.

The paper presents a prioritised set of important information elements that would be of value during a crisis or a rescue mission. It suggests how the information should be collected, stored and distributed, and it suggests information distribution methods supporting a network centric information structure concept. The work is funded by Teleplan and the Norwegian Research Council.

1 INTRODUCTION

In our paper titled "Information grid in support of crisis management" (CCRT symposium, Monterey 2002), we presented shortcomings and possibilities inherent in a national information infrastructure. When considering the vital infrastructures or businesses from a network centric perspective, three grid layers are apparent as illustrated in Figure 1. The upper layer (the business grid) represents the businesses themselves and their interrelationship. The lower layer (the communication grid) facilitates the transportation of the information between businesses, for example through the Internet. The centre layer (the information grid) is made up of the information and knowledge itself as required by the individual businesses. We concluded in our paper that the business grid and the communications grid were highly developed, while the information grid was by far underdeveloped compared to the business grid it is supposed to be a part of. This paper suggests improvements to the information grid architecture.



The modern society is dependent upon the network centric nature of vital business structures. The underlying information structures, however, are still characterised by proprietary formats, organisation, usage and storage of information. As a consequence, bureaucratic procedures are used to regulate flow of information. This brings about a limited ability to respond fast and effectively in a crises situation.

Figure 1. The three network centric infrastructure layers

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It is evident that a network centric crises management concept is desirable, since many of the limitations inherent in today's information grid can be dealt with. It is therefore predicted that a transition from today's trends towards more centralised concepts will gradually shift into a direction where a fully developed network centric crises management concept is the end state.

2 CATEGORIES OF INFORMATION

As was discussed in our earlier paper[2], society is developing into an increasing web of interacting structures and processes, dominated by the developments in information technologies. This results in an increased interdependence between important areas in society, which inevitably leads to new vulnerabilities. In this web, electronic information constitutes an important part of all businesses. However, as of today there are almost no mechanisms providing structure, restrictions and security to this information flow. Seen from a crises management point of view, this is certainly a concern. But as for most businesses, developments in information technology also represent opportunities to enhance abilities to respond to crises. In this respect, all participants of the business grid are potential contributors.

In order to enhance crises response by increased availability of information, a common generic model has to be found applicable to all entities or participants of the business grid. The aim of such a model is to be able to link all businesses to the information grid in a structural and logical way. A simple top level structure is suggested making it possible to categorize all information in four main groups. These are;

- General Public Information
- Products and Services Information
- Rescue and Safety Information
- Surge Capabilities Information

These four categories are depicted in Figure 2 and are more closely described in the following.

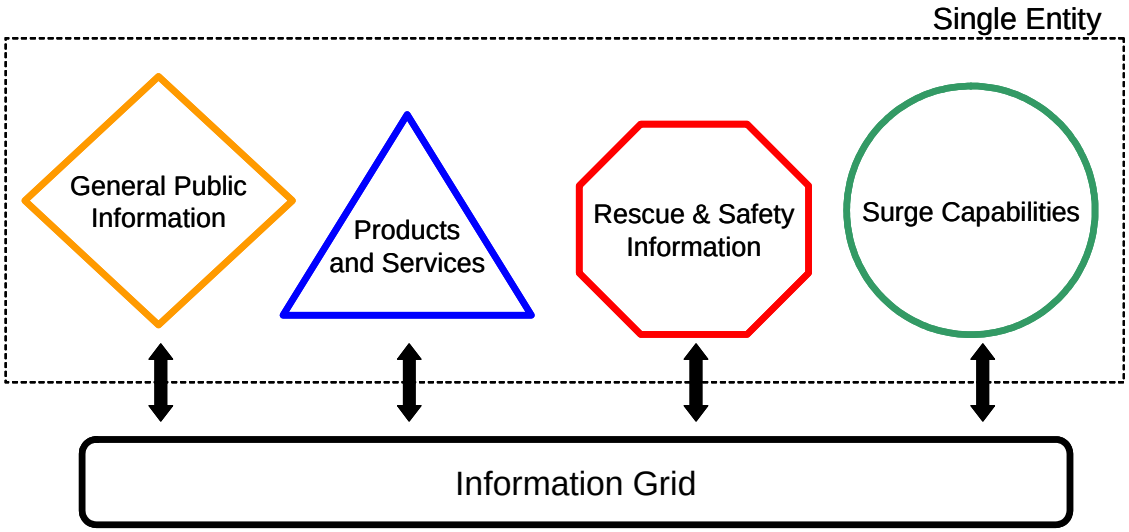


Figure 2. Information based business model

[2] Aarholt, E and Berg, O, "Information Grid in support of Crisis Management", CCRTS, Monterey 11-13 June 2002

2.1 GENERAL PUBLIC INFORMATION

General Public Information is not aimed at serving any particular intention or function rather than to make available to the public general background information such as “about us” web pages. This is a category of information that all businesses and organisations typically put on the internet just to expose themselves, but which do not contribute to the business in any other way than making it possible for the public to recognize their existence. This is basically just an alternative to “Yellow pages”, with more information and less structure. It represents an important element only when supplementing one of the other categories of information, and because of this, standardization has not yet been a priority.

2.2 PRODUCTS AND SERVICES INFORMATION

Products and Services Information is the category that is of direct commercial value to the business. Products and services are either purchased and delivered directly through the information grid, or the ordering and payment are done electronically.

Seen from a customer point-of-view, the value of this is the possibility of quicker and easier service; that is, locating the available selection of offerings and prices. From the provider it represents the possibility to reach out to an enormous number of potential buyers in an extremely easy and cheap way. It can also represent an opportunity to reengineer the whole value chain and offer services at a price previous not possible; for instance due to a dramatic reduction of infrastructure cost. An example of such is internet banking.

The customer would certainly benefit if this category of information was more standardized than it is today. Meanwhile, the provision of shopping comparison portals is big business.

2.3 RESCUE AND SAFETY INFORMATION

Rescue and Safety Information is the category of information that is of importance to one or more parties in case of an emergency or crises situation. As of today, almost no information in this group is made readily available through a common information grid, nor are any common data structures or data models established that makes it easy to utilize such information, if it was available. Some of this information is available to some extent in closed systems belonging to police, fire departments, and commercial security services providers, but in general this information has to be gathered for each individual case and on a larger scale.

If this information was standardized and made available easily and reliably, it would have the potential of making a major contribution to:

- Safety of rescue personnel
- Quicker identification of required resources
- Effective control of escalation/spread
- Protection of most valued assets
- Quicker evacuation and rescue
- Quicker assessment of damage

Due to its importance to a network centric information structure in support of crises management, this category of information is discussed in more detail in the following sections.

2.4 SURGE CAPABILITIES INFORMATION

Surge Capabilities Information is the final category of information. Even though this information is not available today, it is suggested and identified to be of interest both from a commercial and crises management point-of-view. Surge Capabilities Information is defined to be information about available resources in an enterprise or firm that can be utilized for a common cause in case of a crises situation. It is quite possible that government or governmental agencies would be interested in sponsoring and honouring such information due to its potential in enabling the available resources for disposition in a major crises handling situation. From a business point of view, providing this type of information could also make sense. If a mechanism was made available where a company could easily and dynamically post its spare capacity, and thereby make it available to a third party for hire, this could represent a business opportunity to sell temporary spare capacity.

In lack of standardized procedures, it is most likely that this type of information is provided through a broker. This would automatically ensure attention to areas where potential and benefits matter the most. In military business, this way of utilizing resources is part of the Network Centric Warfare concept, and is encouraged amongst others by the development of multi-role capabilities.

3 INFORMATION STRUCTURE

This section takes a closer look at rescue and safety information (see Figure 2 and section 2.3) that should be available in the information system. It is evident that some information, as suggested in Table 1, is vital in support of crisis management, while other types of information are considered of lesser importance. The challenge is to make this information available on a large scale as explained in the next section.

Information element	Information content
Personnel Status Information	Number of people on site, registration of personnel, exact location of personnel, personnel tracking system, personnel with special needs (impaired hearing, sight, disability, medical profile, etc.)
Construction and Infrastructure Information	Location of first aid equipment, emergency exits, fire detectors, fire extinguishers, fire blankets, fire axes, stretchers and other emergency equipment. Detailed construction drawings with cable gates, main switchboard, electrical wiring, main cock, plumbing, sprinkler system, door systems, ventilation systems, fire walls, staircases, floors, lifts and evacuation rooms.
Local Crises Management Team and Equipment	Resources on location, such as personnel with experience in first aid, fire rescue, weapons or negotiations. Availability of technical solutions, such as fire hydrants. Status of electricity and telephone system. The dangers associated with the crisis; for example existence of chemical or biological agents such as gas, acids, drugs, bacteria, virus, radioactive agents, explosives, fuels or weapons.

Information element	Information content
Local Crises Management Plan	Local emergency plans and organisation, emergency preparedness practises, existence of test scenarios. Communications within rescue organisation; such as report lines between rescue leader, assistants, rescue personnel, press, public administration, civil defence, home guard and military. Established physical communication networks; such as telephone, radio, TETRA. Rescue leader, collaboration, who does what. Contact information to local rescue resources.
Alerting, Reporting and Notification Information	Contact information to fire department, police, medical, psychiatric, helicopter, church representative, radiation agency, local government, civil defence, home guard, military agency. Procedures for contacting the above resources.
Area access information	Exact address, geographical information (GPS). Maps of the area and surrounding areas, topographical maps, local authority planning maps with marked water supplies, electrical power, telephone cables, mobile telephone and radio base stations. Area access information; such as infrastructure, one-way streets, blocked access routes, road barriers, parking, helicopter landing areas, etc.

Table 1. Information structure elements

The following paragraphs give a functional and technical description of the information network layout. It is necessary to be aware of the inherent nature of an emergency in that it is always associated with a geographical location. Also, a rescue team always needs to transit from one location to another. The third important factor to remember is the aspect of time.

3.1 NCIS FUNCTIONAL DESCRIPTION

The local business database contains detailed information about the business' safety aspects as indicated in Table 1. The information is maintained by the business itself, and is stored as a link on the business' local intranet and web site.

The main information centre repository contains detailed information about safety aspects of all businesses in the area. The information is automatically collected and updated on a regular basis, either by the local authority operations centre, or it may be moderated by an information broker, such as a local emergency information centre as seen in Figure 3.

All emergency vehicles are equipped with a computer terminal, wireless network and a data base containing the main bulk of information stored in the information centre. This information is automatically updated through a high bandwidth wireless network each time the rescue vehicle returns to its base. Sensitive information can be transferred to the vehicle prior to leaving the base or during transit using available (as of today lower bandwidth) mobile networks. So called "hot-spots" (locations that support high capacity wireless data communications) can also be used for downloading and exchanging information while in transit.

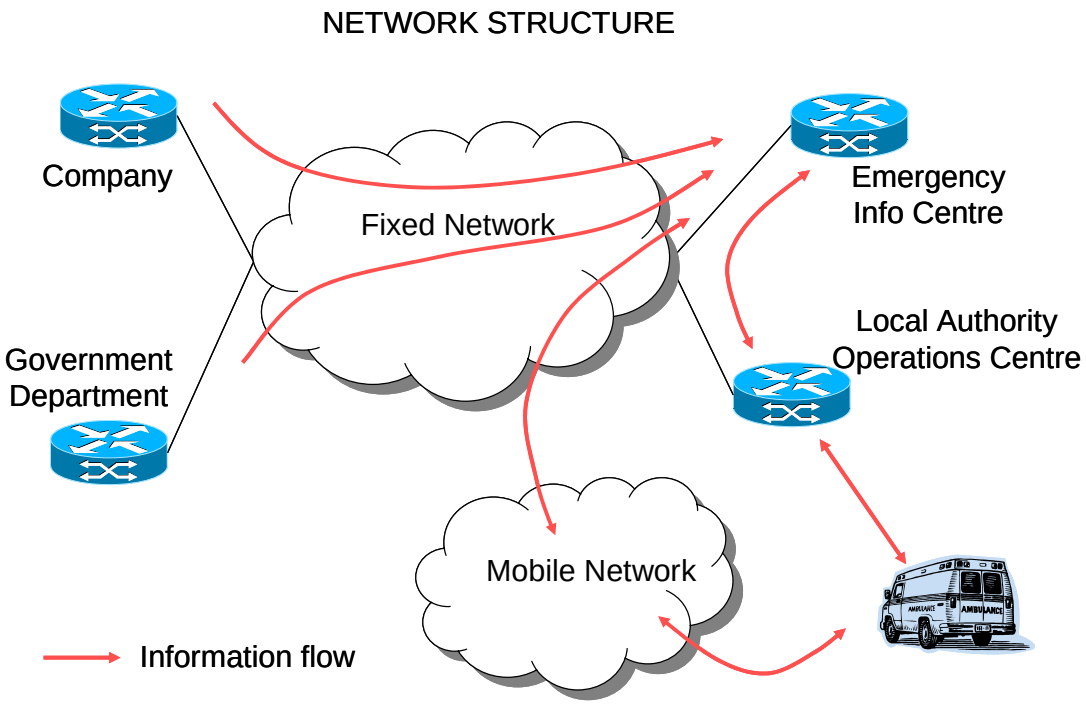


Figure 3. A network structure supporting information flow

In the event of an emergency, the rescue team will have access to detailed information about the emergency location prior to leaving its base. The information can be assessed by the team during transit to the location. We suggest that the relevance of information superiority in military systems is equally relevant in a civilian system, for example a crisis management system.

It should be noted that there is nothing exceptional about this system. It is extremely simple to implement and involves no technical challenges. It is just a matter of agreeing that the information shall be available for emergency use.

3.2 NCIS TECHNICAL DESCRIPTION

Each business (the information owner, also known as the client) allocates an area on its intranet/Internet for emergency information. The information can be maintained by linking the relevant information (graphics or text) to a generic template (word processor or a spread sheet). As information becomes available, the client populates specific locations in the document with the desired information.

The information centre (the information broker, also known as the server) automatically collects (pulls) the information from each business by downloading the information elements over Internet. Some pre-processing may be needed to tag and adapt the available information to the data model (see section 4), and missing data may be added from alternative sources. Security access to each web site can be limited by usual conventional authentication (user and password).

The emergency team (the information user) obtains access to the information published by the information centre through Internet and its local area network. General information is automatically uploaded (pushed) from the information centre, while sensitive information is downloaded (pulled) when needed.

3.3 INFORMATION SECURITY

At the present time it is not clear what type of information security should be adopted; whether the system can use the Internet, a secure virtual private network within the Internet, leased lines or otherwise. The information security should not limit the functional use of the system and is not considered a problem area that cannot be solved. From an information aspect, it is only a matter of balancing the security with the information contents and its functional use.

3.4 USER INTERFACE

The NCIS demonstrator can be realised in numerous ways. This section shows only one implementation of a demonstrator. In addition to the information elements within the demonstrator, a main focus has been to limit the complexity of the system. If information becomes available in a business, there shall be no valid technical reason why the information is not entered into the information database.

As indicated above, the information can be maintained using conventional word processing tools. Since the information is structured in a predetermined format (see the data model in section 4), a generic user interface template is used to simplify information exchange. A simple graphical user interface, such as the one is seen in Figure 4, can be used by the client to populate the information template. The same interface can be used by the user to access the required information.

The upper menu in Figure 4 gives access to Crisis Management value-added processes (elements within the crisis management plan), while the lower menu accesses information elements related to rescue and safety.

3.5 SYSTEM REQUIREMENTS

The system uses standard computers, standard office software tools, existing networks and conventional communication protocols. There is no need to invest in new technology for existing businesses; all that is needed is an area on the business web site and a wish to participate.

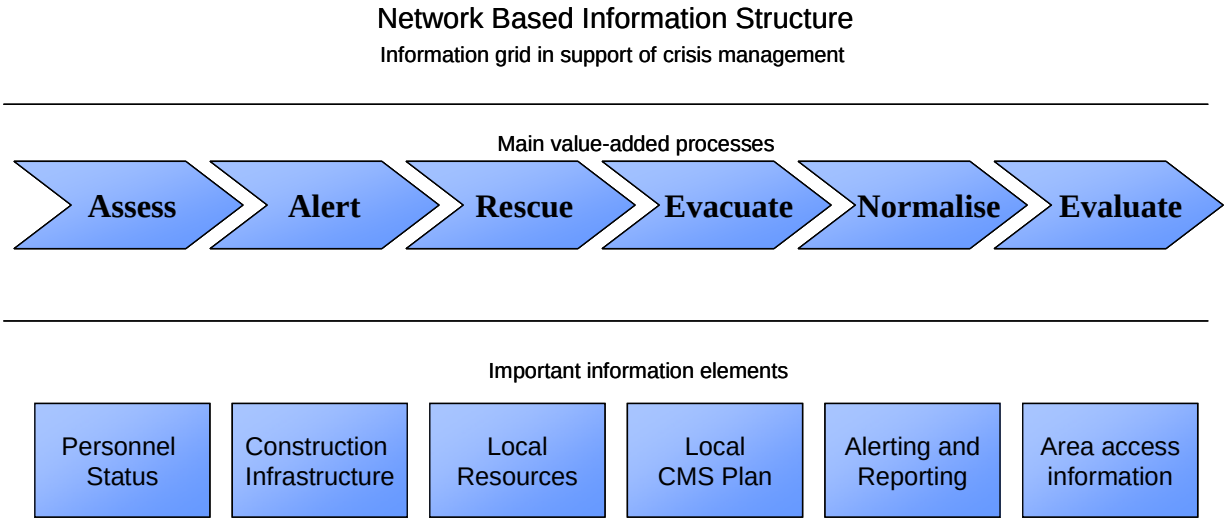


Figure 4. Example of a graphical user interface to access information

4 DATA MODELS AND STANDARDS

The only way to ensure an information grid capable of supporting crises response is to establish a joint government and industry initiative to accelerate the data model (context and semantics) development and at the same time put forward these as general approved standards in the International Organization for Standardization[3] (ISO) community.

Comprehensive crises management requires availability of a common operating picture to emergency responders similar to what is sought in military C4I systems. This requires integration of information from all relevant sources. A rapid response requires quick relay of correct information to the first responders. First of all, this calls for an information technology infrastructure (communication grid) from local to national level. Secondly, it requires a standard terminology to be used across jurisdictions, disciplines and participants of the business grid. Thirdly, this common language and definitions need to be applied through a set of common data exchange standards and data models. In support of this, metadata must be developed and maintained by authoritative sources.

Certainly, there are many standards available of varied suitability that can be used to address one or more of the different rescue and safety category information elements identified in this paper. A complete solution to the information interoperability will consist of a set of standards ranging from management level to technical level.

In order to achieve a successful implementation of rescue and safety information interoperability, the whole process must be guided by overarching standards addressing performance and design, organisational processes and procedures, and interdependent relationships. The ISO 9000 and ISO 14000 families of standards are examples of management standards that could be adapted to guide this effort.

With respect to data management, we suggest a possible approach by looking into some industry standards aimed at enabling efficient transfer and translation of complex technical data to see how they can contribute to the rescue and safety information interoperability challenge. An overview suggesting this is shown in Table 2.

Information element	Status	Possible Candidates for use of standards
Construction and Infrastructure Information	Several data models and standards are being applied	ISO 16739 (Industry Foundation Classes, IFC) part of ISO TC 184/SC 4
Personnel Status Information	Proprietary solutions	ISO 10303-239 Product Life Cycle Support part of ISO TC 184/SC 4
Local Crises Management Team and Equipment	No solutions	ISO 10303-239 Product Life Cycle Support part of ISO TC 184/SC 4

[3] www.iso.org

Information element	Status	Possible Candidates for use of standards
Local Crises Management Plan	Guidelines only	New standards required
Alerting, Reporting and Notification Information	Proprietary Solutions	ISO 10303-239 Product Life Cycle Support
Area Access Information	Many standards related to geographical data	Industry Foundation Classes for GIS (IFG) ISO TC 211

Table 2: Data models and standards in the area of rescue and safety information

A large part of constructions that require standardized data representation are buildings. As of today, the Industry Foundation Classes (IFCs) can be applied to this area. IFCs are data elements that represent the parts of buildings, or elements of the process, and contain the relevant information about those parts. IFCs are used by computer applications to assemble a computer readable model of the facility that constitutes an object-oriented database of the information shared among project participants. The IFCs are being put forward as candidate for ISO standardization.

Another large part of constructions can probably be represented by the ISO 10303 standard. Examples of such constructions are ships and aircraft. The role of the ISO 10303 (STEP standard - Standard for Exchange of Product model data) is to provide a data backbone for product information. The standard defines an integrated information model, which supports multiple views of product data for different applications. Examples of military organisations that mandate the use of STEP are the US Joint Logistics Commanders Group, UK MOD, and the Norwegian Defence Logistics Organisation (NDLO). Several international industrial companies are therefore complying with this standard such as Lockheed Martin, Boeing, BAE Systems, and Northrop Grumman. The Norwegian company EPM Technology[4] are among the world leaders in supporting these companies by offering products, consulting services and technology based upon the STEP/ISO 10303 Standard.

Product Life Cycle Support (PLCS) Inc[5] is a consortium of international companies and government defence organisations, who is seeking to extend STEP to embrace the information exchange requirements for the in-service and disposal phases of a product life-cycle. With respect to crises management, this initiative is interesting, because of its potential to also integrate and standardize availability of data related to personnel status and local crises management team and equipment, if viewed as product support information. The PLCS standard is being developed within the framework of the ISO. It forms an extension to ISO 10303, and it is anticipated that it will achieve approval as a full ISO standard in 2004.

With respect to local crises management plans no standardization seem to exist except from various guides and templates. From a crises management point of view, getting access to local plans are

[4] www.epmtech.jotne.com
[5] www.plcs.org

important to coordinate local, state and national emergency responses. For instance, partially executed local plans represent valuable information related to evacuation of people. Both management standards similar to ISO 9000 and ISO 14000 will have to be developed together with specific data standards making content of local plans available through the information grid.

Alerting, reporting and notification information is another area where no standards are applied. The information is usually held in a local database, but is not accessible to other organisations. This data does not require models with rich semantics, and does not require a great deal of effort to standardize. The easier approach is probably to make it part of a standardized crises management plan.

The last part of crucial information with respect to emergency response is area access information. In some cases the IFCs can be a part of this, but for the most the relevant standards in this area are being put forward by the ISO/TC 211 group, which is responsible for the ISO geographic information series of standards. Today, several companies are making business from providing dynamic data, for instance for navigation. One example of this covering both the U.S. and Europe is "*True Time Maps™ Dynamic Tools for Real-World Driving*" provided by Tele Atlas[6]. However, a solution covering all relevant factors influencing area access is not available commercially and would probably have to be initiated and partially funded by the government.

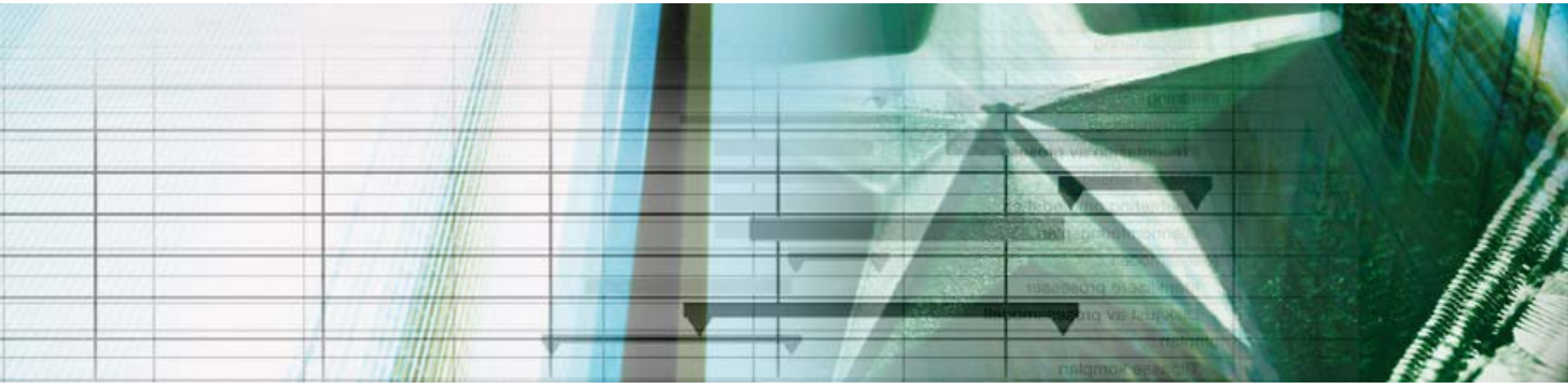
5 SUMMARY AND CONCLUSIONS

In this concept paper, we have detailed an implementation of a simple network centric information system well suited to assist local authorities in crisis information management. Some simple steps in terms of detailing the information structure and at the same time making businesses talk to each other over the communication grid, will alleviate local authority of the burden of obvious lack of crisis management.

The initiative is really in the hands of those responsible for crisis management at any level. And if some more of the suggestions in our information based business model are taken into account, then it may even be possible to make some business out of being prepared for crisis management.

[6] www.teleatlas.com

CCRTS San Diego 15-17 June 2004



Network Centric Information Structure Crisis Information Management

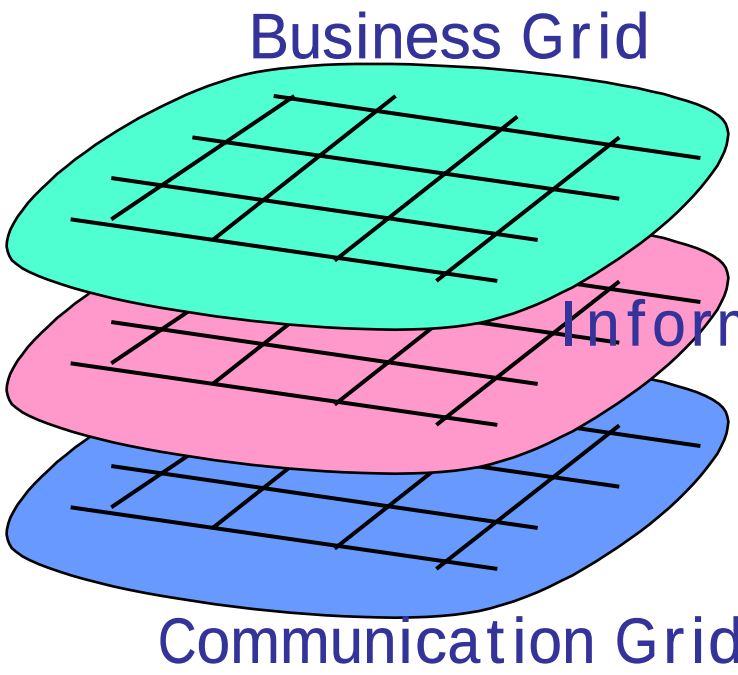
Dr Eldar Aarholt and Mr Olav Berg

Teleplan

Contents

- **Network Infrastructure Layers**
- **Generic Information Categories**
- **Network Centric Information Structure**
  - NCIS system requirements
  - NCIS technical description
  - NCIS demonstrator
- **Data Models and Standards**
- **Conclusions**

Maturity of Infrastructure Layers



- **The business grid and the communications grid are highly developed**
- **The information grid is highly underdeveloped**
- **We have some suggestions to improve the information grid architecture that will assist information exchange**

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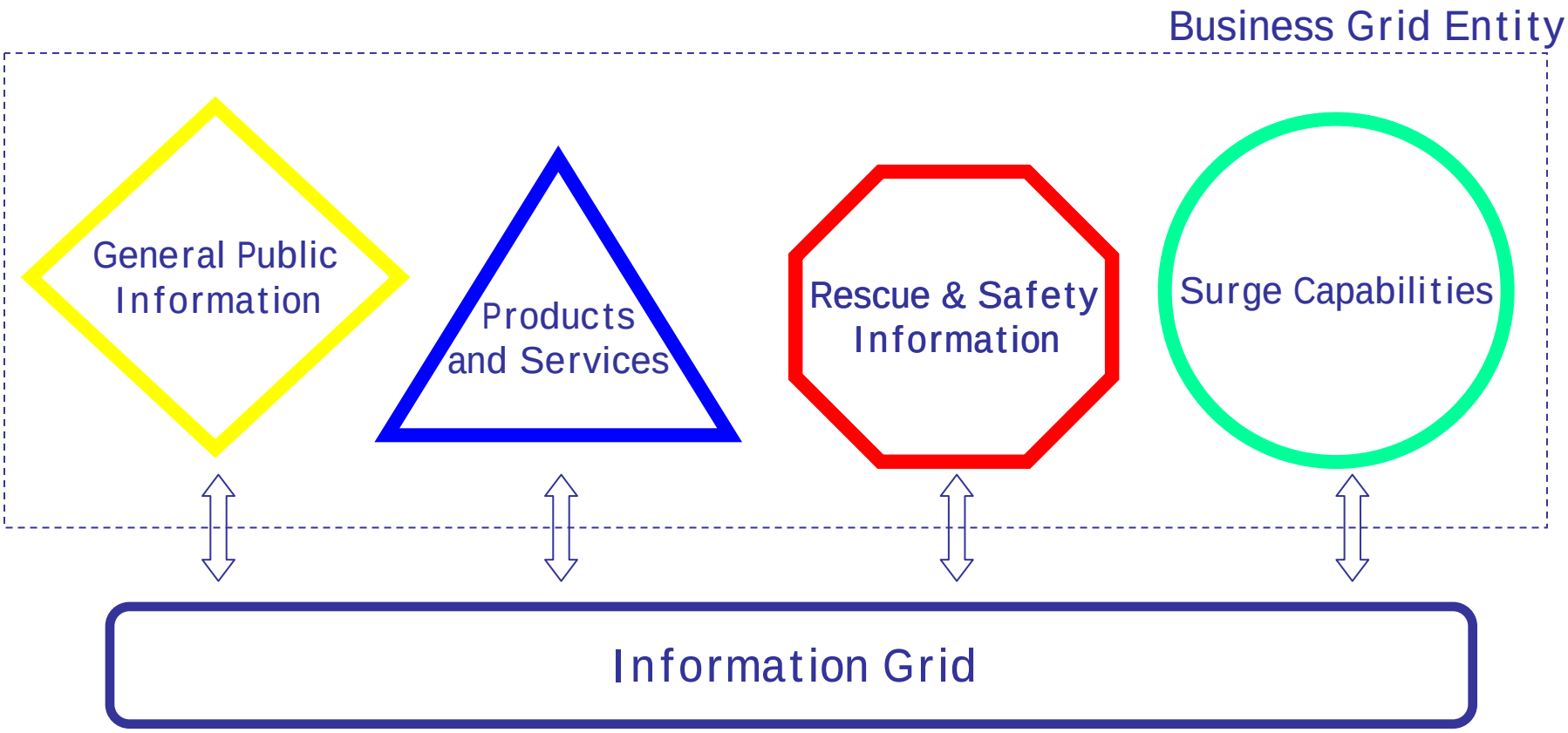
Generic Information Categories



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Benefits of Improved Availability

- Improved Safety of rescue personnel
- Quicker identification of required resources
- Effective control of escalation/spread
- Protection of most valued assets
- Quicker evacuation and rescue
- Quicker assessment of damage

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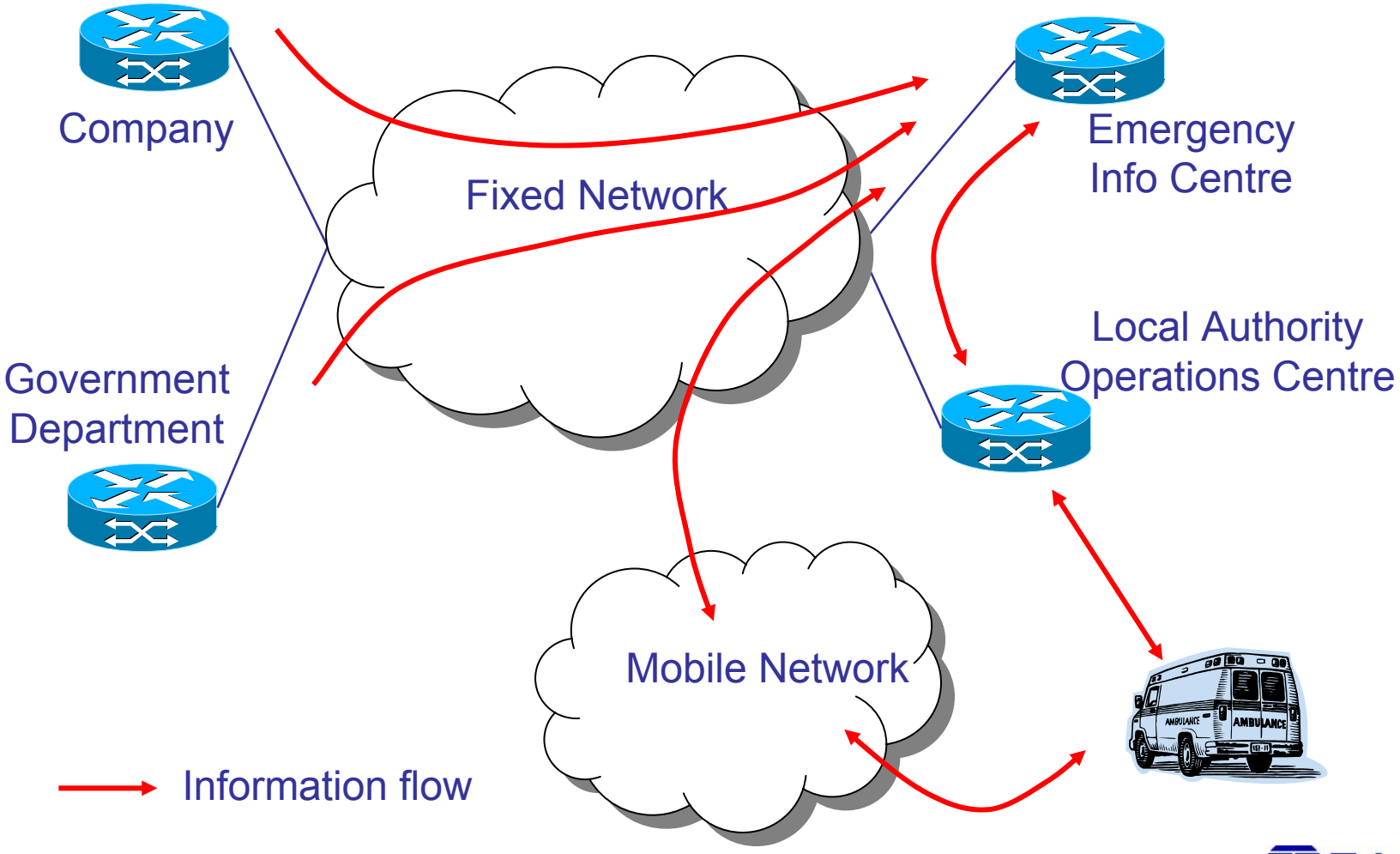
Network Information Flow



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NCIS System Requirements

- The Network Centric Information Structure (NCIS) system uses standard computers, standard office software tools, existing networks and conventional communication protocols.
- There is no need to invest in new technology for existing businesses; all that is needed is an area on the business web site and a wish to participate.

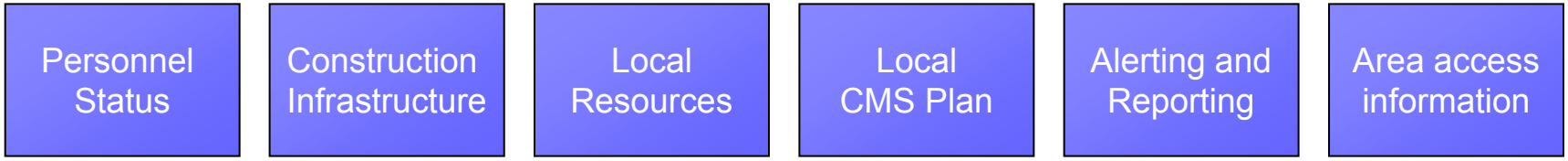
NCIS Technical Description

- Each business (the client) allocates an area on its intranet/Internet for emergency information. The information is maintained by linking it to a generic template (word processor or a spread sheet). As information becomes available, the client populates the document with information.
- The information centre (the server) automatically collects (pulls) the information from each business over Internet. Security access is limited by conventional authentication.
- The emergency team (the information user) obtains access to the information published by the information centre through Internet. General information is automatically uploaded (pushed) from the information centre, while sensitive information is downloaded (pulled) when needed.

NCIS User Interface

- The NCIS demonstrator can be realised in numerous ways, but a main focus is to limit complexity of the system. There shall be no valid technical reason why information is not entered into the information database.
- The information is maintained using conventional word processing tools. If the information is structured in a predetermined format, a generic user interface template can be used to simplify information exchange.
- A simple graphical user interface is used by the client to populate the information template. The same interface is used by the user to access the required information.

Network Centric Information Structure



- **The information is divided into six information elements**
- **The purpose of the network centric information structure is to provide specific information relating to the above information elements**

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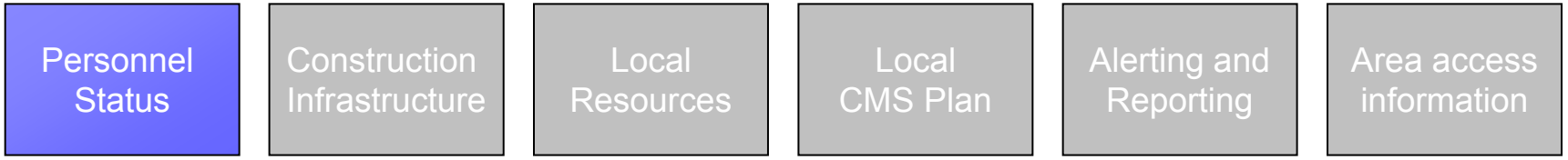
Network Centric Information Structure



- **Number of people on site**
- **Registration of personnel**
- **Exact location of personnel**
- **Personnel tracking system**
- **Personnel with special needs (impaired hearing, sight, disability, medical profile, etc.)**

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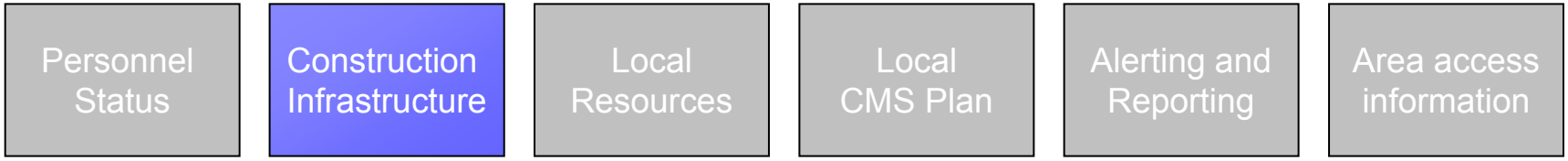
Network Centric Information Structure



- Location of first aid equipment, emergency exits, fire detectors, fire extinguishers, fire blankets, fire axes, stretchers and other emergency equipment
- Detailed construction drawings with cable gates, main switchboard, electrical wiring, main cock, plumbing, sprinkler system, door systems, ventilation systems, fire walls, staircases, floors, lifts and evacuation rooms

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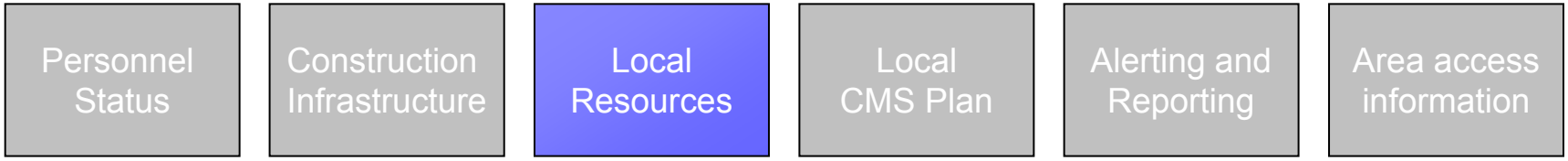
Network Centric Information Structure



- Resources on location, such as personnel with experience in first aid, fire rescue, weapons or negotiations. Availability of technical solutions, such as fire hydrants. Status of electricity and telephone system
- The dangers associated with the crisis; for example existence of chemical or biological agents such as gas, acids, drugs, bacteria, virus, radioactive agents, explosives, fuels or weapons

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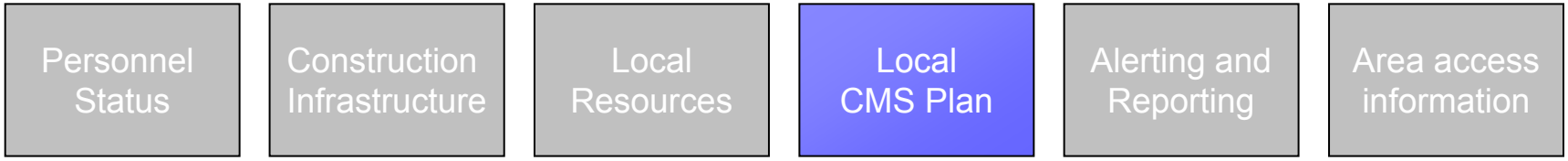
Network Centric Information Structure



- Local emergency plans and organisation, emergency preparedness practises, existence of test scenarios.
- Communications within rescue organisation; such as report lines between rescue leader, assistants, personnel, press, public administration, civil defence, home guard and military
- Established physical communication networks; such as telephone, radio, TETRA
- Rescue leader, collaboration, who does what
- Contact information to local rescue resources

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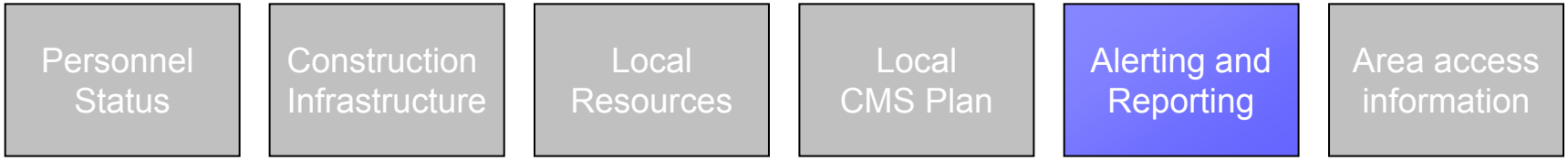
Network Centric Information Structure



- **Contact information to fire department, police, medical, psychiatric, helicopter, church representative, radiation agency, local government, civil defence, home guard, military agency**
- **Procedures for contacting the above resources**

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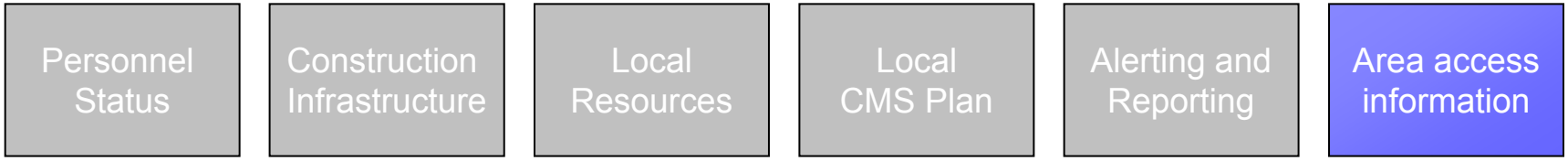
Network Centric Information Structure



- **Exact address, geographical information (GPS)**
- **Maps of the area and surrounding areas, topographical maps, local authority planning maps with marked water supplies, electrical power, telephone cables, mobile telephone and radio base stations**
- **Area access information; such as infrastructure, one-way streets, blocked access routes, road barriers, parking, helicopter landing areas, etc.**

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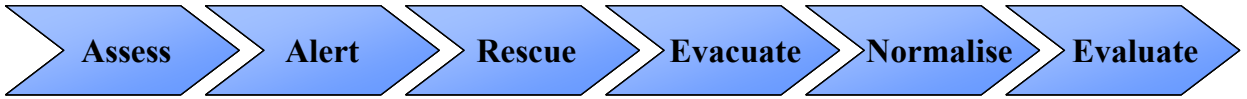
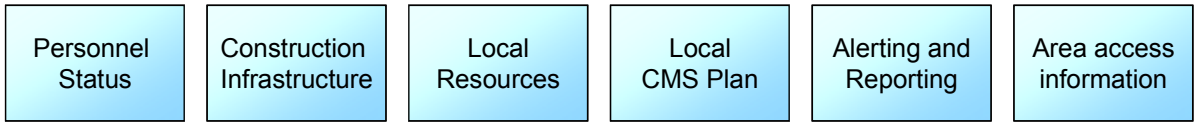
NCIS Demonstrator

- The demonstrator is basically a web-page filled with specific information at specific locations
- NCIS Demo





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Data Models

- Comprehensive crises management requires a common operating picture to emergency responders similar to what is sought in military C4I systems.
- This requires quick integration of information from all relevant sources.
- First of all, this calls for an information technology infrastructure (communication grid) from local to national level.
- Secondly, it requires a standard terminology to be used across jurisdictions, disciplines and participants of the business grid.
- Thirdly, this common language and definitions need to be applied through a set of common data exchange standards and data models.
- In support of this, metadata must be developed and maintained by authoritative sources.

ISO 10303-239

Relevant Data Models and Standards

Information element	Status	Possible Candidates for use of standards
Construction and Infrastructure Information	Several data models and standards are being applied	ISO 16739 (Industry Foundation Classes, IFC) part of ISO TC 184/SC 4
Personnel Status Information	Proprietary solutions	ISO 10303-239 Product Life Cycle Support part of ISO TC 184/SC 4
Local Crises Management Team and Equipment	No solutions	ISO 10303-239 Product Life Cycle Support part of ISO TC 184/SC 4
Local Crises Management Plan	Guidelines only	New standards required
Alerting, Reporting and Notification Information	Proprietary Solutions	ISO 10303-239 Product Life Cycle Support
Area Access Information	Many standards related to geographical data	Industry Foundation Classes for GIS (IFG) ISO TC 211

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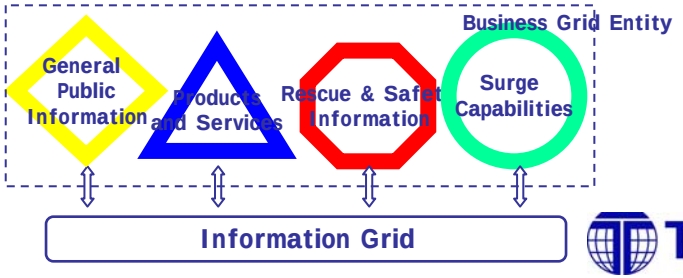
Conclusion

Personnel Status | Construction Infrastructure | Local Resources | Local CMS Plan | Alerting and Reporting | Area access information

- In this concept paper, we have detailed an implementation of a simple network centric information system well suited to assist local authorities in crisis information management.
- Some simple steps in terms of detailing the information structure and at the same time making businesses talk to each other over the communication grid, will alleviate local authority of the burden of obvious lack of crisis management.
- The initiative is really in the hands of those responsible for crisis management at any level.
- And if some more of the suggestions in our information based business model are taken into account, then it may even be possible to make some business out of being prepared for crisis management...



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